



# **Multi-Gas Monitor (MGM)**

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# Multi-Gas Monitor Hardware & Display

- **Box Mass: 2.6 kg**
- **Dimensions: 23 x 20 x 10 cm**
  - **With internal batteries for portable operations**
  - **USB power include recharging batteries**
  - **Tunable diode laser spectroscopy based instrument with enhanced pathlength and wide wavelength range**
- **Measures the following parameters of the cabin atmosphere**
  - **Oxygen ( $O_2$ ) and Carbon Dioxide ( $CO_2$ )**
  - **Ammonia ( $NH_3$ ) and Water vapor ( $H_2O$ )**
  - **Plus Temperature (T) and Pressure (P)**

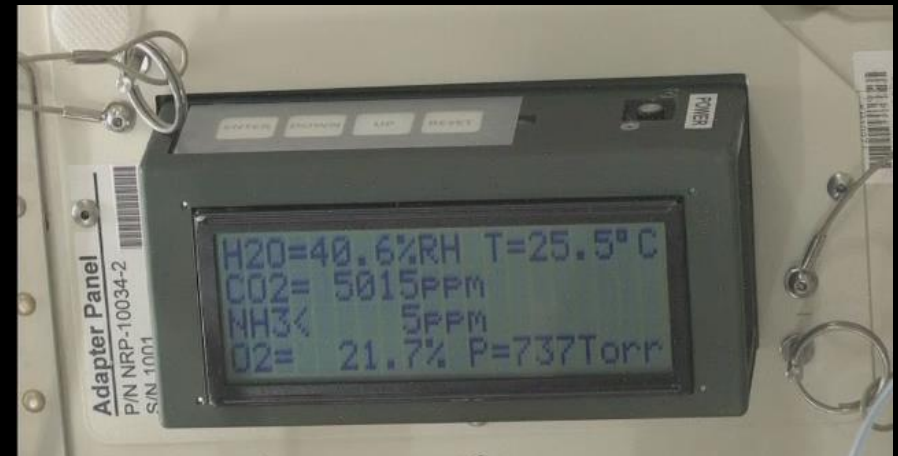


## MGM Display

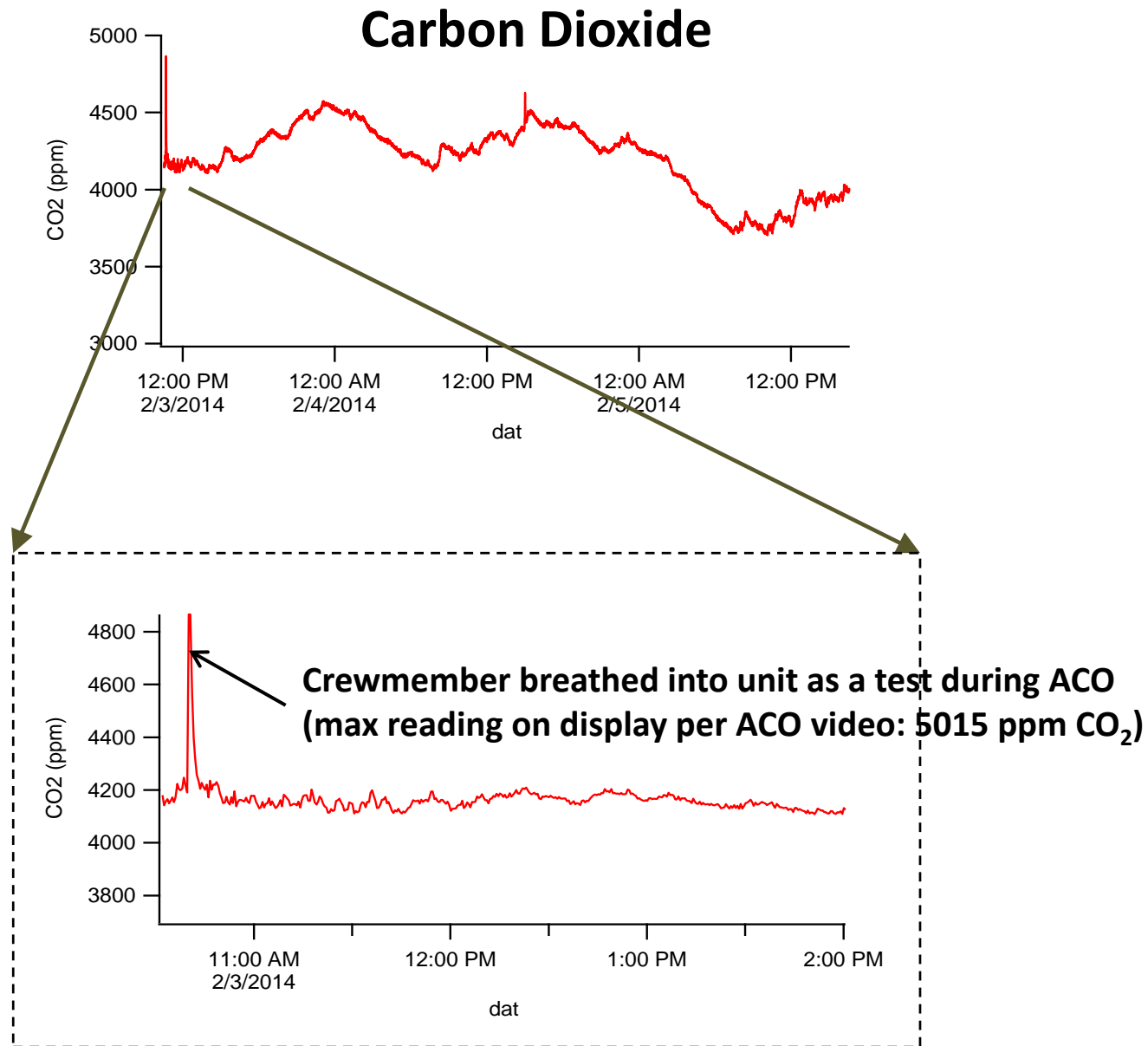


# MGM Technology Demonstration

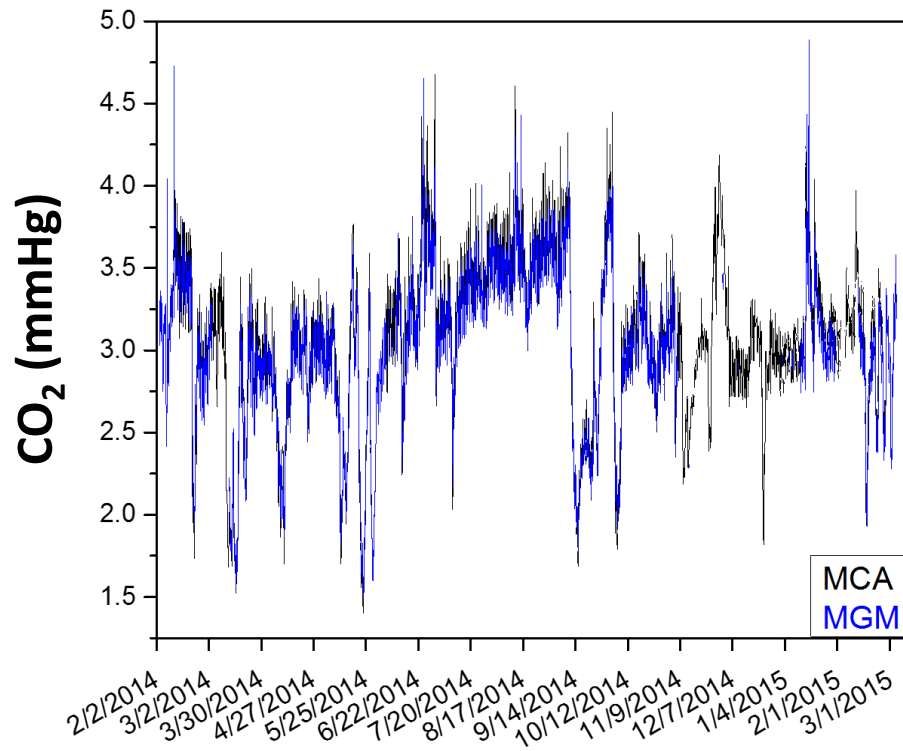
- Launched on 37 Soyuz in Nov 2013
- Installed Feb 3, 2014 in JEM ER5 Locker 2 in Nanoracks Frame 2
- Activated Feb 3, 2014
- Demonstrated
  - Collects data continuously
  - Long term stability in real spacecraft environment
  - Real-time  $\text{NH}_3$  monitor (5 ppm – 20,000 ppm)
- Future: Demonstrate operational capability including portability



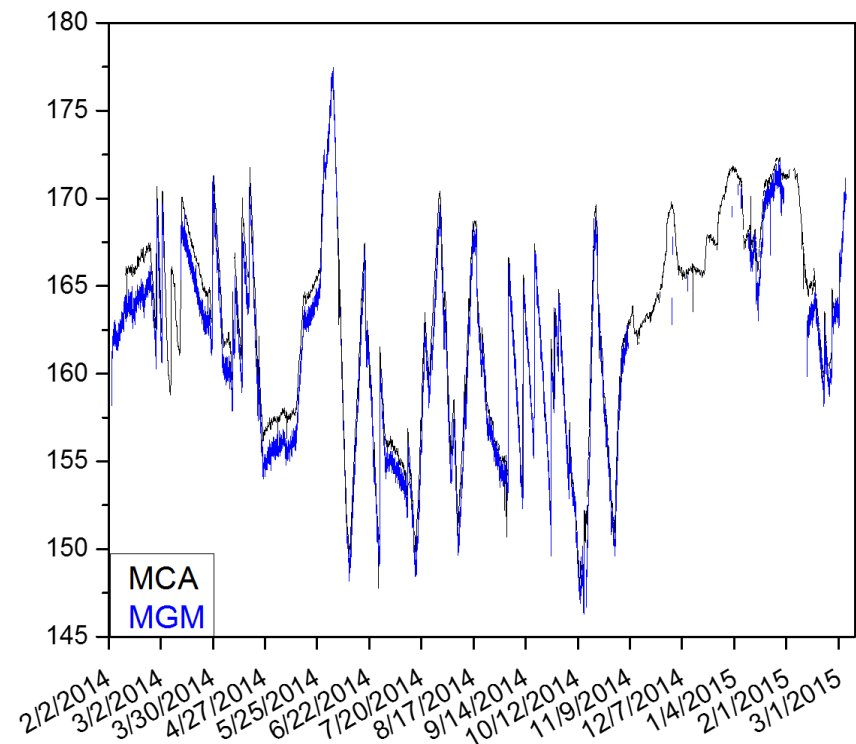
# MGM Activation/Checkout



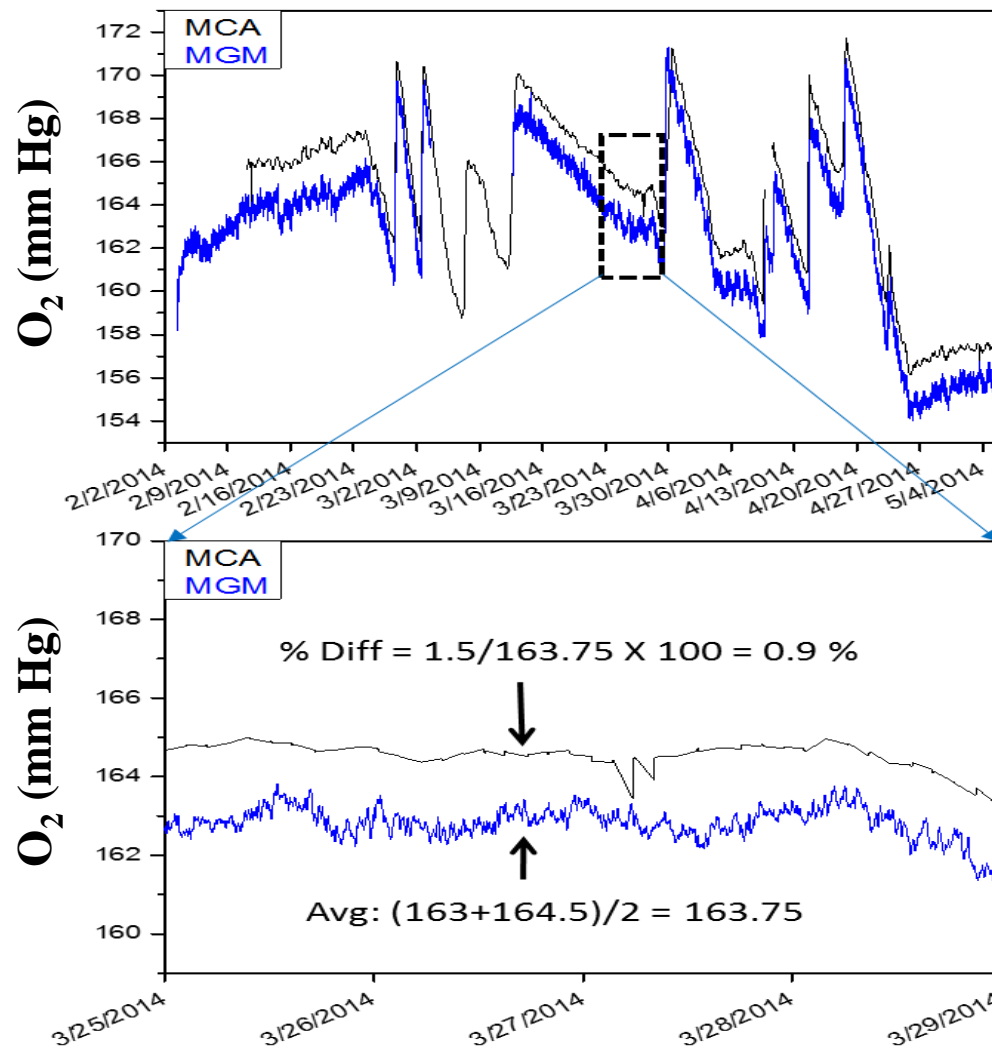
# Latest CO<sub>2</sub> and O<sub>2</sub> plots



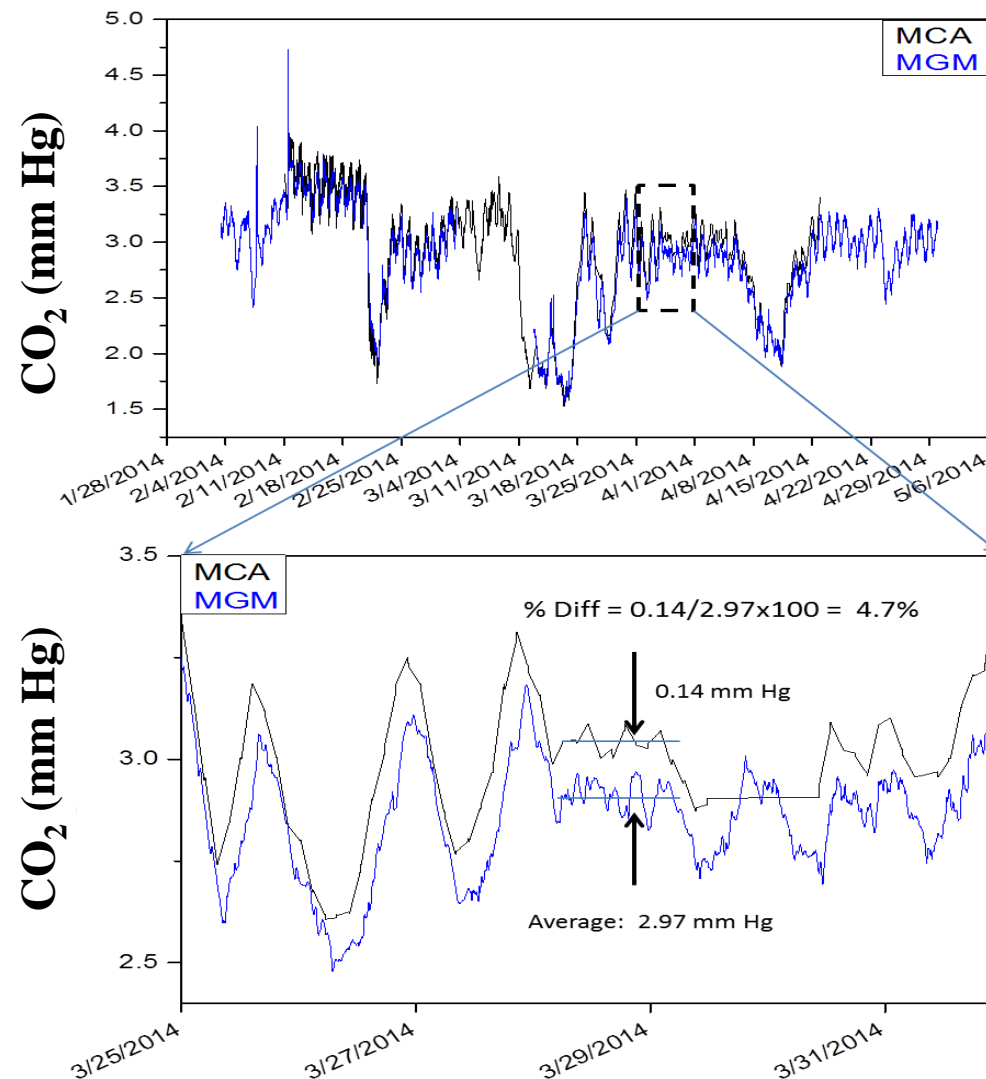
O<sub>2</sub> (mmHg)



# Oxygen Compared With The Major Constituent Analyzer



# Carbon Dioxide Compared With The Major Constituent Analyzer



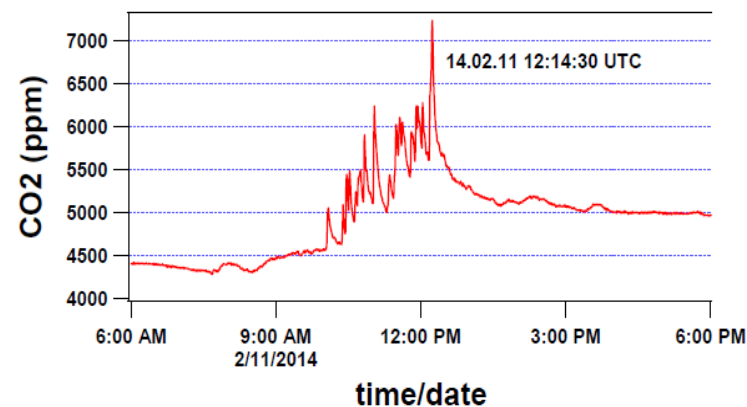


# SPHERES/RINGS operating in JEM

- Uses CO<sub>2</sub> gas thrusters

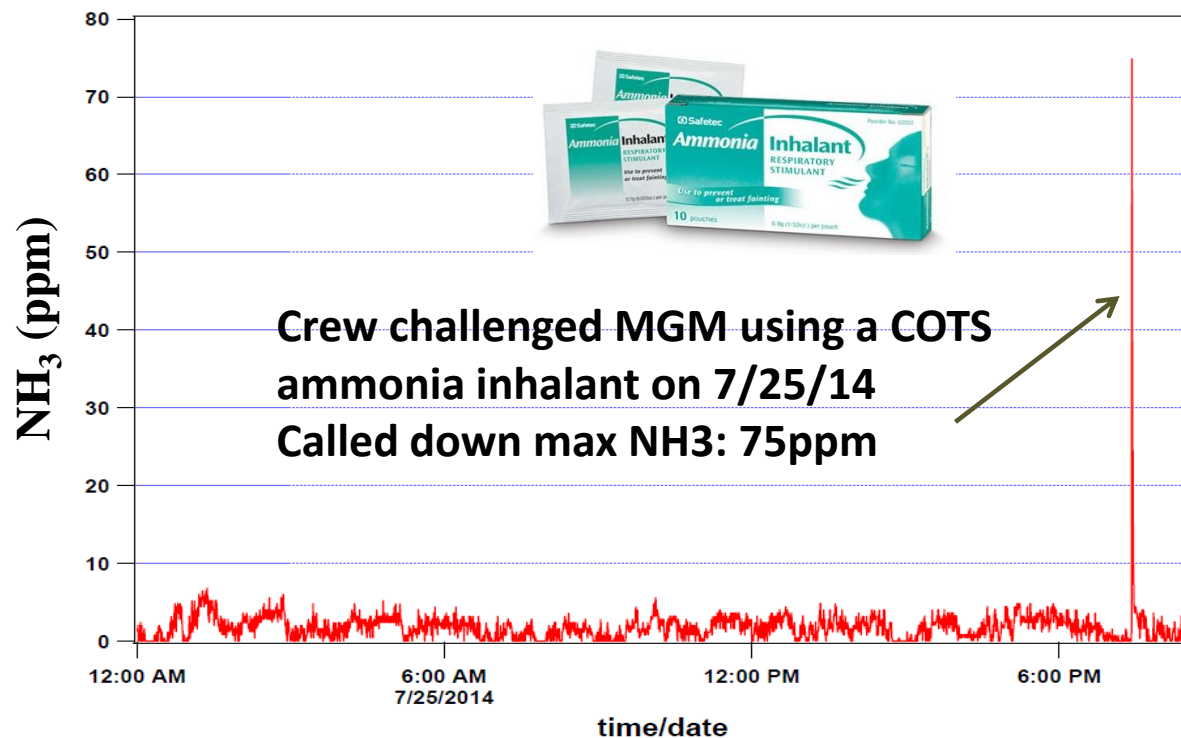
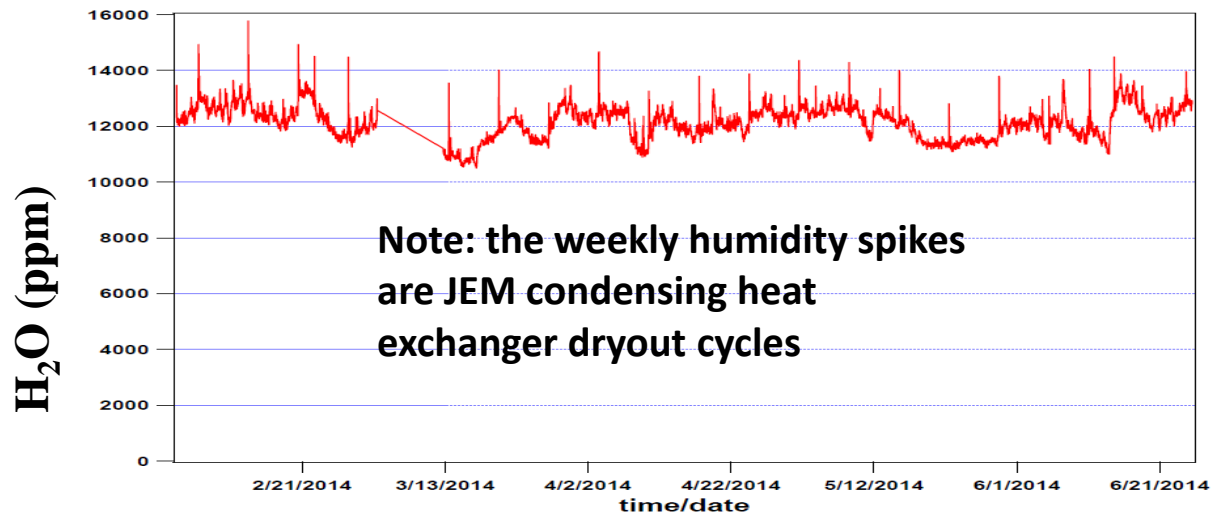


Interesting unexpected  
“challenge” for MGM  
February 2014





# More Results: Water & Ammonia



# Other Potential Target Compounds

- HCl, HF, CO<sub>2</sub> HCN CH<sub>4</sub>, HBr, NO<sub>x</sub>,
- ppm-percent range (could go to ppb depending on compound and “sample time”)
- Mid-IR opens more compounds
- Continuous and fast response (30 sec to 90%), but higher levels are much quicker

# Potential MGM Applications

- Industrial (Oil/Gas)
- Methane and leaks of carbon dioxide
- Water vapor in natural gas
- Medical
  - Ammonia (end point for dialysis)
- Confined space and perhaps for first responders
  - Submarines
  - Mines
- First Responders
- Agriculture-plant health
  - Ethylene



## **Multi-Gas Monitor (MGM)**

Multi-Gas Monitor is a flight experiment, a technology demonstration to test the ability of tunable diode laser spectroscopy based instrument to stay in calibration long term and follow events and dynamics occurring with the cabin atmosphere. MGM measures 4 gases: oxygen, carbon monoxide, ammonia and water vapor, as well as temperature and pressure. This month marked one year of successful and continuous MGM operation on ISS. The crew successfully tested the ammonia channel using a commercially available inhalant. MGM has detected some interesting dynamics inside Japanese Experiment Module (JEM) as a result of CO<sub>2</sub> thruster firings from the SPHERES/RINGS payload and water spikes from dry out cycling of the JEM heat exchangers. Results to date have given us high confidence in the technology such that we believe this could have applications in the energy and medical sectors. This presentation will summarize the testing and results of the unit on ISS and suggest areas of use within the energy and medical arenas.